disk towards the outer margin. On the posterior wings the metallic colouring at the base of both wings and in the discal band across the posterior wings is more bluish and less golden green, while the black velvety spots in the band are more extended inwardly; the outer edge of the band is further from the outer margin and more convex between the veins. Both wings are broader and more rounded at the apex.

Expanse of wings $1\frac{3}{8}$ inch.

Hab. New Britain.

LVI.—*Observations on the Derivation and Homologies of some Articulates.* By James D. Dana *.

The term Articulates is used here in preference to Arthropods, because the latter group is believed to be not a natural one, Crustaceans and Insects being less closely related to one another, as indicated beyond, than Annelids and Insects.

Derivation of Limuloids and Crustaceans.—As has been suggested by Lankester, it is probable that all the Articulates are successional to the Rotifers. There is reason for believing further that the types of Annelids, Crustaceans, and probably that of Limuloids had their independent Rotifer origin.

The Nauplius, or larval form of a Crustacean, shows, by its having but three pairs of limbs (two besides an antennary pair), that the type is not successional to a many-jointed Annelid, but rather to some *Pedalion*-like Rotifer. The discoveries of Prof. C. E. Beecher announced in the preceding and earlier numbers of this 'Journal' leave no doubt that the Trilobites are multiplicate Isopod Crustaceans, precursors of the normal Isopods, as the true Phyllopods, also multiplicate species, were precursors of the Decapods †.

The Eurypterids, the early form of the Limuloids, are related to Crustaceans in number of body-segments, it being 19, as in the Tetradecapods, and in the fact that 13 of these 19 segments pertain to the thorax and abdomen. But the wide distinction exists that the Eurypterids have no thoracic or

* From the 'American Journal of Science,' May 1894, pp. 325–329.

† In the Author's 'Report on the Crustacea of the Wilkes Exploring Expedition,' the Rotifers are made the lowest subdivisions of Crustacea (p. 1408), and the Trilobites are placed, with a query, in the subdivision of Tetradecapods, as multiplicate forms under the type. In the text above the expression *true* Phyllopods is used, because most of the so-called Phyllopods of the Palæozoic exhibit, in the specimens, no evidence that they are multiplicate, that is, have an excessive or abnormal number of body-segments or appendages.

abdominal limbs, and the only true feet which they have are also at base mouth-organs, that is organs that pertain to the head. Moreover, as has been shown by Packard and others for the *Limulus*, they do not pass through the Nauplius stage in their development. These diversities and agreements appear to indicate a derivation for the Limuloids nearly like that of the Crustacean type, but probably not *from* Crustaceans. But since Limuloids cannot yet be proved to have existed before the Trenton period in the Lower Silurian, a derivation from some species related to the Ceratiocarids is possible. Since many, if not all, of the Eurypterids were freshwater or brackish-water species, the transfer to fresh water may have been an incident attending the divergence, and also an explanation of their attaining so great dimensions, fresh water having been their protection. The large Eurypterids, several feet in length, would have been helpless among Sharks and Ganoids.

Derivation of Arachnids.—The line to the lower and earlier Arachnids, that is, to the Scorpions, leads up, according to Van Beneden, Packard, and others, from the early *Pterygotus*-like Limuloids. The early Scorpion, as well as the modern kinds, has the same number of body-segments as a *Eurypterus* or *Pterygotus*—namely, 7 thoracic and 6 abdominal (precisely the normal number in Crustaceans),—the same *cephalic* relations of the legs, the same absence of abdominal appendages, a like absence of thoracic appendages from all the segments excepting the first two, and similar functions in the members pertaining to these two segments. Further, according to B. Peach, these early Limuloids sometimes have, like the Scorpions, pairs of "combs" or pectinated organs on the underside of some of the thoracic segments.

But in this change from an aquatic to a terrestrial species the upward progress in structure was great. The four posterior pairs of feet in the terrestrial Scorpion have no longer the low-grade feature of serving as jaws as well as feet, but are simply feet; they are the chief organs of locomotion, and only those of the anterior pair are appendages to the mouth. The antennæ are shortened to pincers (falces), that also serve the mouth. The four pairs of feet are thus *cephalic* organs, if comparison be made with the Limuloids and Crustaceans, though in arachnology they are called *thoracic*. In the later true Spiders the body had lost its true Eurypteroid abdomen, but had still, in Palæozoic species, its distinctly segmented thorax; and this thorax is the abdomen of arachnology. It is segmented in some modern species, while in others the subdivisions have become obsolete or are but faintly indicated.

The abdomen of the Eurypterid, however, exists as a slender-jointed thread in *Geralinura* of Scudder, of the Carboniferous, which has its Illinois and also Bohemian species, and has survived till now in the modern *Telyphonus*.

Derivation of Myriapods and Insects.—Myriapods, although inferior to Insects, are as yet known only from the early Devonian. The Devonian species, and also those of the Carboniferous, are of the Millepede or lower doubly multiplicate section of Myriapods, with one exception, that of the remarkable few-jointed caterpillar-like *Palæocampa* of Meek and Worthen.

The fact of a line of succession from Worms to Myriapods and from Myriapods to Insects has not been proved by geological discovery. The derivation of Myriapods from some type of Annelids is zoologically suggested, as long since recognized, by the apparently transitional form of *Peripatus*, a low-grade Myriapod resembling much the larva of some Insects, and by the like multiplicate structure of Annelids and Myriapods. It might be inferred also from the resemblance of the *Palæocampa* of the Illinois Carboniferous to the caterpillar of an Insect of the genus *Arctia*, as remarked by Scudder.

Myriapods are regarded as the precursors of Insects on account of their approximate resemblance to the latter in antennæ and the appendages of the mouth, and because also of the worm-like form of most Insect larvæ, these larvæ appearing to be survivals of the Myriapod stage. In the change from an Annelid and Myriapod to an Insect the *multiplicate* feature disappeared and the number of parts became essentially the fixed normal number of the type, both as regards the body-segments and their jointed appendages.

The rise of grade from the Myriapod to the Insect involved the appropriation of the three body-segments of the Myriapod bearing the three anterior pairs of feet (which correspond normally to half the body-segments of the head of an Isopod Crustacean) for forming the isolated middle section of the body, called the thorax, and the suppression of all the other pairs of feet. In both Spiders and Insects the change involved also a general concentration of the structure toward the cephalic nervous centre, that is a shortening of the range of cephalic control, and especially the distance to the posterior limit of locomotive action. Compared with a crab, the highest type in the Crustacean series, its superior, an ant, is a very little thing.

The fact that in low-grade Insects there is no proper metamorphosis, while in the higher, as they rise in grade, the

Crustaceans.		Limuloids.						Arachnids.				Myriapods.		Insects.	
Tetradecapods.		*Eurypterus.*		*Pterygotus.*		*Limulus.*		*Scorpion.*		*Phrynus.*		*Lithobius.*			
1. 1st Ant.	Head.	0	Head.	Ant.	Head.	Ant.	Head.	Falces	Head	Falces	Head	Ant.	Head.	Ant.	Head.
2. 2nd Ant.		M-P.		M-P.		M-P.		M.		M.		M.		M.	
3. M.		M-P.		M-P.		M-P.		P.	Thorax.	P.	Thorax.	Mx.		Mx. & L.	
4. Mx.		M-P.		M-P.		M-P.		P.		P.					
5. Mx.		M-P.		M-P.		M-P.		P.		P.		P.	Abdomen.	P.	Thorax
6. Mx.		M-P.		M-P.		M-P.		P.		P.		P.		P.	
												P.		P.	
1. P.	Thorax.	Fol. P.	Thorax.	Fol. P.	Thorax.	Fol. P.	Thorax.	0		0	Abdomen.	P.			
2. P.		Fol. P.		Fol. P.		Fol. P.		Comb.		0		P.		0	Abdomen.
3. P.		0		0		Fol. P.		0		0		P.		0	
4. P.		0		0		Fol. P.		0		0		P.		0	
5. P.		0		0		Fol. P.		0		0		P.		0	
6. P.		0		0		Fol. P.		0		0		P.		0	
7. P.		0		0		0		0		0		P.		0	
										0		P.		0	
1. App.	Abdomen.	0	Abdomen.	0	Abdomen.	0	Abdomen.	0	Abdomen.	0		P.		0	
2. App.		0		0				0				P.		0	
3. App.		0		0				0				P.			
4. App.		0		0				0				P.			
5. App.		0		0				0							
6. App.		0		0				0							
												15 pairs of feet in *Lithobius*, 21 in *Scolopendra*, 200 in some Myriapods.			

larval stage is lower and lower in embryonic level, suggests that the larval stage results from an attendant retrograde embryonic change to a line parallel with the Myriapod, and beyond to the memberless condition of a worm. The principle appears to be a general one among animals, and thence the higher the species the longer the stage of youth.

The relations in body-segments and limbs between the classes of Crustaceans, Limuloids, Arachnids, Myriapods, and Insects are shown in the table (p. 505). The segments of the body are numbered along the left margin; the zero opposite signifies that the segment, though present, has no appendage.

In this table the following abbreviations are used:—Ant., antenna; App., pairs of jointed appendages, either pediform or branchial; M., mandible; Mx., maxilla; P., feet; M-P., feet that serve also as jaws; Mx. & L. (under Insects), maxillæ and labium; Fol. P., foliaceous or lamellar feet or appendages.

Under the Limuloids the genus *Eurypterus* fails of antennæ, but they are present in *Pterygotus* and are chelate; and this chelate (or thumb-and-finger) form characterizes also the modern *Limulus*, the Scorpions, and the common Spiders. In the table the two pairs of maxillæ of Insects are assumed to belong to a single body-segment, as held by many zoologists, including (as he himself informs the writer) Prof. S. I. Smith; the table shows that, with this admission, the thorax and head of an Insect are essentially homologous with the head of a Tetradecapod Crustacean.

LVII.—*New Species of* Cyclophorus *and a* Spiraculum *from the Khasi and Naga Hills, Assam.* By Lieut.-Col. H. H. Godwin-Austen, F.R.S. &c., and Col. R. Beddome, F.L.S. &c.

Cyclophorus Muspratti, sp. n.

Shell umbilicated, turbinate, slightly keeled; sculpture, apex smooth, the whorls thence are longitudinally ribbed and striated, increasing in strength near the suture from above downwards, and crossed by the lines of growth, producing a decussate surface; this is coarser and rougher on the last whorl and under surface. Colour madder-brown, crossed by mottled broken white lines on whorls 3 and 4. Spire conic,